Assessment of Existing Conditions Relative to Narrative Water Quality Objectives

This section describes conditions in the Big Bear Lake watershed that resulted in the inclusion of Rathbun Creek, Summit Creek, and Grout Creek as nutrient impaired on the 1994 303(d) list (Table A-1). Nutrient data that were evaluated and compared to the objectives for Rathbun Creek, Summit Creek, and Grout Creek as part of the initial TMDL problem identification were the data collected in 1994 by the Regional Board as a follow-up to the Clean Lakes Study (Table A-2), data collected from 1994-2000 by the BBMWD (Table A-3), tributary data collected by the Regional Board in 1998 (Table A-4), data collected by the SBCFCD as part of the stormwater sampling program from 1994-2000 (Table A-5) and data collected from 2001-2003 by the TMDL Task Force (Table A-6). For all datasets, tributary data are compared to Basin Plan Objectives specified in Section 2.1 of the TMDL document. For all creeks, no data exceed narrative water quality objectives for nitrate-N; unionized ammonia could not be calculated for the most part because temperature and pH were not taken simultaneously to the water quality sample. Dissolved oxygen was not recorded and chlorophyll *a* analyses were not conducted. Total nitrogen and TP concentrations are much higher for the tributaries when compared to Big Bear Lake water quality.

Total Phosphorus, TIN, Nitrate as N, Un-ionized ammonia. The nutrient-related data used to place Rathbun Creek, Summit Creek, and Grout Creek on the 1994 303(d) list were collected as part of a Clean Water Act Section 314 grant (Clean Lakes Study) titled, "Investigation of Toxics and Nutrients in Big Bear Lake." (Courtier and Smythe 1994). The data were collected between April 1992 and April 1993 (Table A-1).

Table A-1. Nutrient concentrations (µg/L) for the 303(d) listed creeks (April 1992-April 1993)

	Total P	Total N	TIN	NO3-N
Rathbun Creek at Fox Farm Rd.				
Average	65	1100	764	685
Median	65	1100	764	685
Number of samples	2	2	2	2
Number of non-detects	0	0	NP	0
Max	80	1400	1263	1170
Summit Creek at Swan Dr.				
Average	22	713	546	472
Median	20	400	315	260
Number of samples	3	3	3	3
Number of non-detects	1	0	NP	1
Max	40	1440	1223	1130
Grout Creek – North of Hwy 38				
Average	18	273	231	268
Median	20	200	85	268
Number of samples	3	3	3	2
Number of non-detects	1	0	NP	1
Max	30	520	532	510

NP = detection limit not provided

Data from 1994 were also used to assess the creeks for nutrients (Table A-2).

Table A-2. Nutrient concentrations (µg/L) for the 303(d) listed creeks (May 1994)

	Total P	Total N	TIN
Rathbun Creek at Fox Farm Rd.	30	1305	155
Number of samples	1	1	1
Summit Creek at Swan Dr.	50	965	585
Number of samples	1	1	1
Grout Creek – North of Hwy 38	10	1205	385
Number of samples	1	1	1

Data collected by the BBMWD from 1994-2000 were also evaluated (Table A-3).

Table A-3. Nutrient concentrations (µg/L) for the 303(d) listed creeks (BBMWD:1994-2000)

	Total P	Total N	TIN*	NO3-N**
Rathbun Creek				
Average	108	743	285	325
Median	50	600	200	200
Number of samples	23	23	23	23
Max	910	1500	1100	1100
Grout Creek				
Average	40	336	N/A	N/A
Median	25	350	N/A	N/A
Number of samples	14	14	14	14
Max	130	500	100	100

*TIN was calculated as the difference between TN and TKN (ammonia was below detection limits). Average and median TIN values for Grout Creek were all 0 µg/L.
Only one sample had a value above 0 µg/L.
**Only one Grout Creek sample had a value above the detection limit for nitrate-N.

Data collected by the Regional Board in 1998 at various sites in Rathbun Creek were also assessed for nutrients. As can be seen in Table A-4, the total phosphorus and TIN concentrations are high for all locations in the creek.

Table A-4. Nutrient concentrations (µg/L) for Rathbun Creek (1998)

	Total P	Total N	TIN	NO3-N
Rathbun Creek – Below Bear Mtn.				
Average	470	2110	1055	990
Number of samples	2	2	2	2
Max	590	2265	1545	1480
Rathbun Creek – Below Zoo				
Average	265	1785	1375	1310
Number of samples	2	2	2	2
Max	270	2305	2045	1980
Rathbun Creek – At Parking Lot				
Average	370	1030	770	705
Number of samples	2	2	2	2
Max	610	1315	1005	940
Rathbun Creek – At mouth				
Average	195	730	575	510
Number of samples	2	2	2	2
Max	260	795	585	520

Data collected by the SBCFCD as part of their NPDES monitoring program from 1994 to 2000 were also evaluated for nutrients (Table A-5).

Table A-5. Nutrient concentrations (µg/L) for Rathbun Creek (SBCFCD:1994-2000)

	Total P	Total N	TIN
Rathbun Creek – Site 6 First Flush (FF)			
Average	593	2183	513
Median	320	1600	400
Number of samples	23	23	23
Max	3600	8300	1800
Rathbun Creek – Site 6 Main Program (MP)			
Average	640	2041	514
Median	490	1600	450
Number of samples	22	22	22
Max	3800	7200	1800
Rathbun Creek – Site 7 First Flush (FF)			
Average	393	1950	795
Median	155	1850	750
Number of samples	22	22	22
Max	3700	5300	1900
Rathbun Creek – Site 7 Main Program (MP)			
Average	340	1919	786
Median	220	1900	800
Number of samples	21	21	21
Max	1300	4100	1900

TMDL Monitoring

Starting in June 2001, a program of monthly nutrient monitoring at seven tributary stations was initiated as part of the nutrient Total Maximum Daily Load (TMDL) process and is presently ongoing. The seven main tributary monitoring sites are Metcalf Creek at Highway 18 (MWDC1), Bear Creek Outlet (MWDC2), Grout Creek at Highway 38 (MWDC3), Rathbun Creek at the mouth (MWDC4), Summit Creek at Swan Dr. (MWDC5), Rathbun Creek at the zoo (MWDC6), Summit Creek below the ski area parking lot (MWDC7), and Knickerbocker Creek (MWDC8a) (Figure 2-1 – main document). Data from June 2001 to February 2003 are included in the analysis for the 303(d) listed tributary sampling stations (i.e., MWDC3, MWDC4, MWDC5, MWDC6, and MWDC7). Grab, first flush and flow composite samples were analyzed for total nitrogen, total dissolved nitrogen, ammonia-N, nitrate plus nitrite-N, total phosphorus, total dissolved phosphorus and orthophosphate-P.

As shown in Table A-6, these data were evaluated against the nutrient narrative objectives. Unionized ammonia could not be calculated because temperature was not determined at the time of sampling. Values of total phosphorus and total nitrogen are much higher than those observed in Big Bear Lake.

Table A-6. Nutrient concentrations (µg/L) for the 303(d) listed creeks (June 2001- February 2003)

Site	Type of sampling	Total P	Total N	TIN
Rathbun Creek at the mouth (MWDC4)	Grab			
Average		1685	1102	305
Median		1685	1102	305
Number of samples		2	2	2
Max		1842	1114	339
Rathbun Creek at the mouth (MWDC4)	First flush			
Average		1261	2176	719
Median		1303	2244	715
Number of samples		4	4	4
Max		1767	2789	916
Rathbun Creek at the mouth (MWDC4)	Flow composite			
Average		1081	2520	1038
Median		1157	1881	832
Number of samples		4	4	4
Max		1488	4817	2054
BMZoo on Rathbun Creek (MWDC6)	Grab			
Average		102	3174	2613
Median		108	3343	2793
Number of samples		4	4	4
Max		134	4582	3875
Grout Creek at Hwy 38 (MWDC3)	First Flush	1680	1719	98
Grout Creek at Hwy 38 (MWDC3)	Flow composite	935	1224	126
Table A-6 cont'd				
Summit Creek at Swan Dr. (MWDC5)	Grab			

Table A-6 cont'd

Average		141	1190	842
Median		36	219	23
Number of samples		5	5	5
Max		507	4236	3730
Summit Creek at Swan Dr. (MWDC5)	First Flush	961	1923	581
Summit Creek at Swan Dr. (MWDC5)	Flow composite			
Average		886	2200	859
Median		886	2200	859
Number of samples		2	2	2
Max		1094	2404	883
Summit Creek PK West (MWDC7)	Grab			
Average		562	3427	2263
Median		209	3395	1980
Number of samples		3	3	3
Max		1312	4098	2915

TIN was calculated by summing the individual values of nitrate + nitrite and ammonia.

Hydrology of the Rathbun Creek, Summit Creek, and Grout Creek subwatersheds

Shown in Figures A-1 and A-2 are the total annual simulated flows and average monthly simulated flows in AF for Rathbun, Summit, and Grout Creeks. The wettest year for the 14-year period, 1990-2003, was 1993. The majority of the flows occur during the winter with February contributing the greatest loads (Figure A-2). For the past few years, runoff due to precipitation and snowmelt has been the lowest in years. Since the inception of the TMDL monitoring effort in 2001, there has been no detectable flow in Grout Creek until the winter of 2003. Rathbun Creek and Summit Creek have also only been sampled on a few occasions because of the lack of flow.

Rathbun Creek, Summit Creek, and Grout Creek comprise approximately 18%, 2%, and 13%, respectively, of the total Big Bear Lake watershed area. These three subwatersheds contribute a third of the total runoff to the lake.

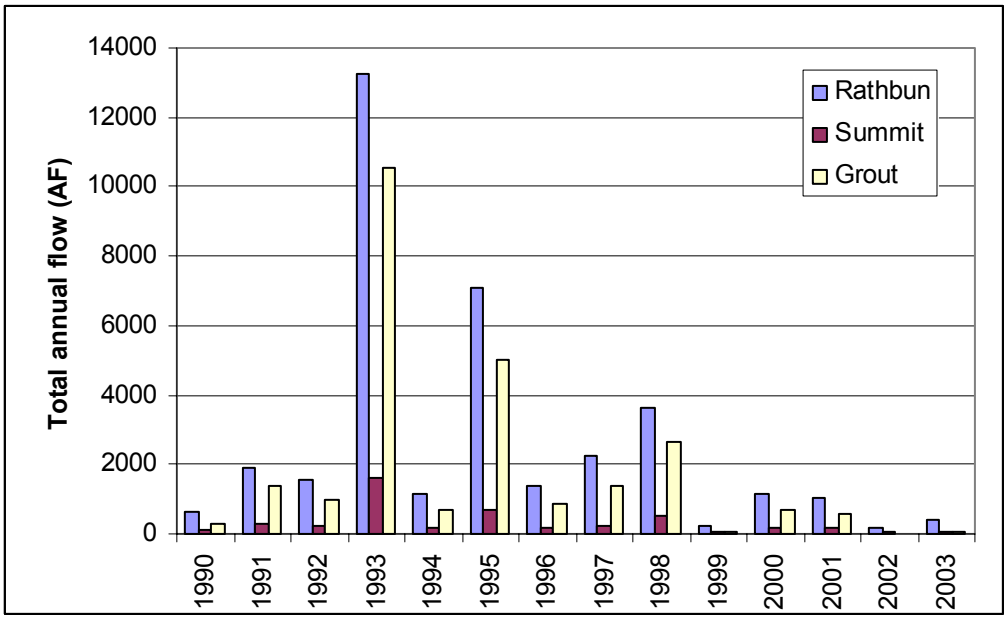

Figure A-1: Total annual simulated flow from HSPF land uses for Rathbun Creek, Summit Creek, and Grout Creek, 1990-2003 (WY)

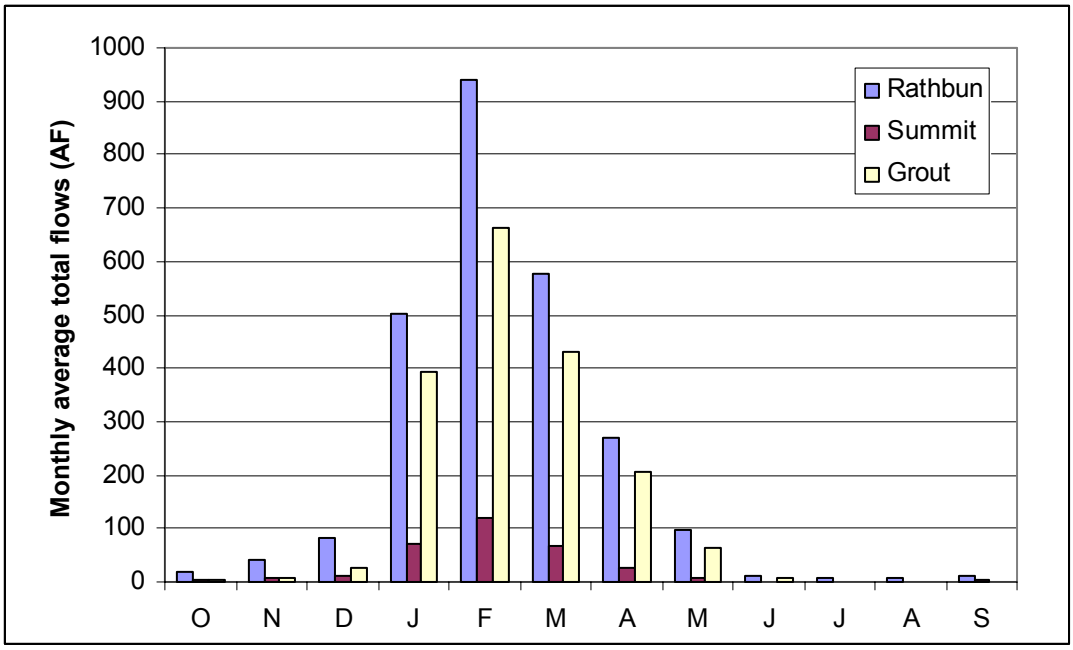

Figure A-2: Monthly trends of average total flow for Rathbun Creek, Summit Creek, and Grout Creek, 1990-2003 (WY)

Nutrient loads

Annual total nitrogen and total phosphorus loads to Rathbun Creek, Summit Creek, and Grout Creek subwatersheds for 1990 to 2003 are shown in Table A-7. Nutrient loads to these tributaries were not actually simulated due to the lack of monitoring data for model calibration. Instead, a ratio of subwatershed area to the total Big Bear Lake watershed area was determined for each pervious/impervious land use of the three tributaries (see Table 1-3 in the main document). This weighted percentage was then multiplied by the total nutrient loads to Big Bear Lake for each land use to obtain total phosphorus and total nitrogen loads for the different land uses for the three creeks.

The average percent contribution on an annual basis for Rathbun Creek, Summit Creek, and Grout Creek was 27%, 6%, and 3%, respectively, for total nitrogen and 21%, 4%, and 6%, respectively, for total phosphorus for the period, 1999-2003 (Table A-7).

Table A-7. Simulated annual total nutrient loads to the 303(d) listed tributaries for the 14 year period, 1990-2003 (WY)

WATER YEAR*	CREEK	TP LOAD (LBS)	BIG BEAR LAKE TP LOAD (LBS)	PERCENTAGE OF TP ANNUAL LOAD	TN LOAD (LBS)	BIG BEAR LAKE TN LOAD (LBS)	PERCENTAGE OF TN ANNUAL LOAD
1990	RATHBUN	95	455	21%	1316	4806	27%
1991		361	1814	20%	5728	18471	31%
1992		200	955	21%	3892	12508	31%
1993		15877	98016	16%	39910	130850	31%
1994		163	779	21%	2941	9719	30%
1995		3412	20995	16%	15529	58746	26%
1996		292	1324	22%	2545	8512	30%
1997		503	2207	23%	4212	13555	31%
1998		1358	7693	18%	9860	31130	32%
1999		70	326	21%	569	2574	22%
2000		382	1845	21%	2280	7854	29%
2001		137	650	21%	2585	8451	31%
2002		53	248	21%	433	1958	22%
2003		73	343	21%	600	2710	22%
1999-2003 AVERAGE		**143**	**682**	**21%**	**1293**	**4709**	**27%**
1990-2003 AVERAGE		1641	9832	17%	6600	22275	30%
MAX		15877	98016		39910	130850	
MIN		53	248		433	1958	
1990	SUMMIT	18	455	4%	274	4806	6%
1991		68	1814	4%	1142	18471	6%
1992		34	955	4%	779	12508	6%
1993		2220	98016	2%	7295	130850	6%
1994		29	779	4%	592	9719	6%
1995		600	20995	3%	2779	58746	5%
1996		49	1324	4%	476	8512	6%
1997		71	2207	3%	784	13555	6%

Table A-7 cont'd

1998		257	7693	3%	1904	31130	6%
1999		14	326	4%	116	2574	5%
2000		65	1845	4%	449	7854	6%
2001		24	650	4%	526	8451	6%
2002		11	248	4%	88	1958	5%
2003		15	343	4%	122	2710	5%
1999-2003 AVERAGE		**26**	**682**	**4%**	**260**	**4709**	**6%**
1990-2003 AVERAGE		248	9832	3%	1238	22275	6%
MAX		2220	98016		7295	130850	
MIN		11	248		88	1958	
1990	GROUT	19	455	4%	155	4806	3%
1991		110	1814	6%	753	18471	4%
1992		63	955	7%	532	12508	4%
1993		13660	98016	14%	7084	130850	5%
1994		46	779	6%	386	9719	4%
1995		2089	20995	10%	2863	58746	5%
1996		108	1324	8%	449	8512	5%
1997		210	2207	10%	746	13555	6%
1998		729	7693	9%	1460	31130	5%
1999		6	326	2%	47	2574	2%
2000		161	1845	9%	363	7854	5%
2001		38	650	6%	324	8451	4%
2002		5	248	2%	36	1958	2%
2003		7	343	2%	50	2710	2%
1999-2003 AVERAGE		**43**	**682**	**6%**	**164**	**4709**	**3%**
1990-2003 AVERAGE		1232	9832	13%	1089	22275	5%
MAX		13660	98016		7084	130850	
MIN		5	248		36	1958	

* A water year runs from October 1 through September 30 of the next year.

Figures A-3 and A-4 show nutrient loads from forest, resort and urban land uses for the three creeks during two different periods. The percentages of average total P and total N contributed by the three land uses for each creek varies for both periods. The forest land use contributes the greatest total N and total P loads for Grout Creek which has no resort land use, while the resort and urban land uses (residential and high density urban (HDU) combined) contribute the greatest total nitrogen and total phosphorus loads to Summit Creek. The urban land use contributes the majority of total P loads to Rathbun Creek while the urban and resort land uses contribute the majority of total N loads to this creek.

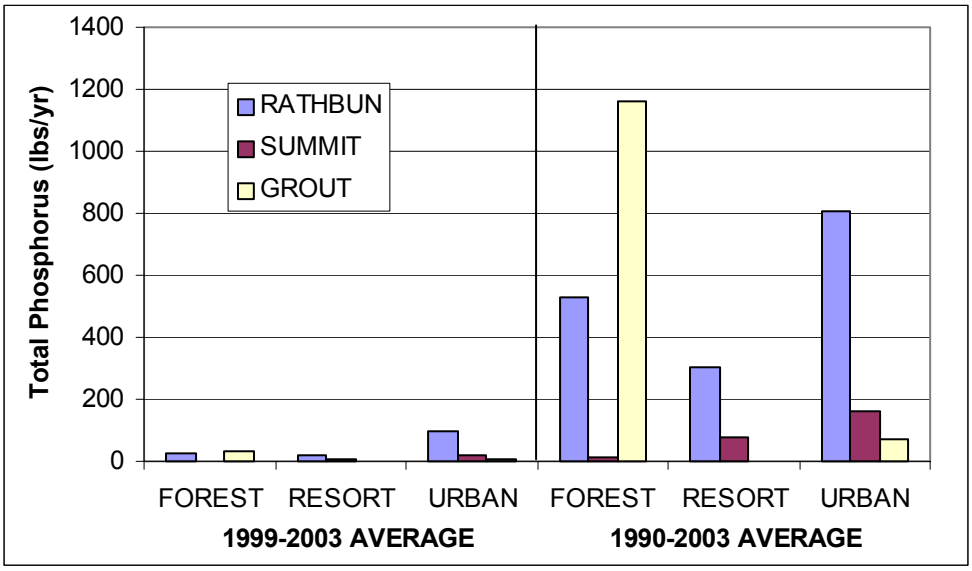

Figure A-3: Percentage of average total phosphorus for HSPF model land uses for each 303(d) listed tributary during a 5-yr period, 1999-2003, and 14-yr period, 1990-2003

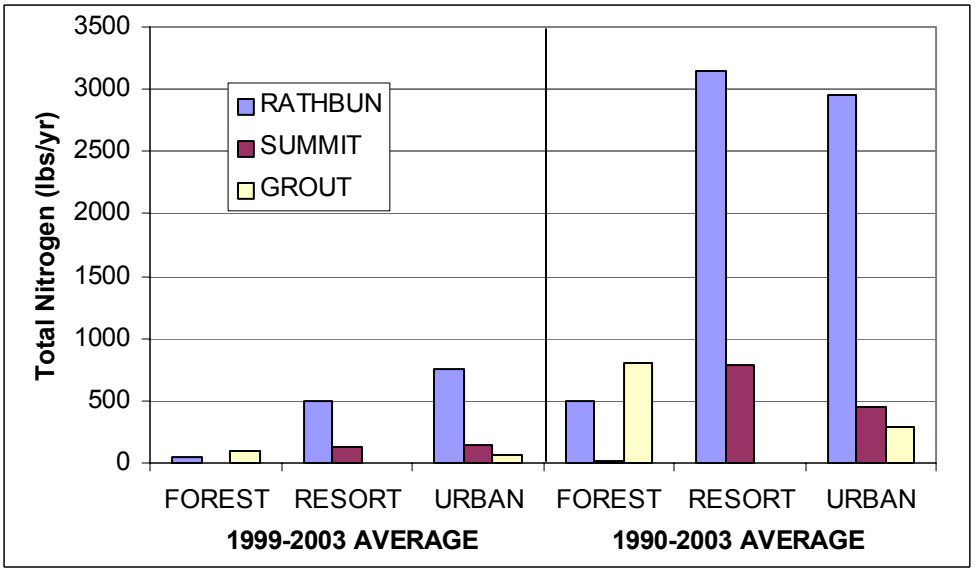

Figure A-4: Percentage of average total nitrogen for HSPF model land uses for each 303(d) listed tributary during a 5-yr period, 1999-2003, and 14-yr period, 1990-2003

Nutrient sources and corresponding loads for the three tributaries are summarized in Tables A-8, A-9 and A-10. Rathbun Creek contributes the highest nutrient loads of any of the three creeks which is in agreement with previous studies (Courtier and Smythe 1994; Siegfried and Herrgesell 1979a, 18). Resort and urban loads contribute 35% and 54% of the total nitrogen loads to Rathbun Creek for the last 5 years (1999-2003) (Table A-8). During a wet year (i.e., 1993), total nitrogen loads are 37 times the amount for resort and 23 times the amount for urban land uses observed during 1999-2003. The average annual total phosphorus loads during a wet year (i.e., 1993) are 23 times the amount for forest land uses during the last five years, 1999-2003.

Table A-8. Total nutrient loads to Rathbun Creek in lbs

Parameter	Forest NPS Load[1]	Resort NPS Load[2]	External Point Source Load[3]	Total Measured Load[4]
1990-2003				
TOTAL NITROGEN	858	3,276	3,217	7,351
% OF TOTAL	11.7%	44.6%	43.8%	
TOTAL PHOSPHORUS	2,729	1,125	2,841	6,695
% OF TOTAL	40.8%	16.8%	42.4%	
EXTREME WET EVENT (1993)				
TOTAL NITROGEN	4,509	19,740	19,288	43,537
% OF TOTAL	10.4%	45.3%	44.3%	
TOTAL PHOSPHORUS	15,683	7,285	18,621	41,589
% OF TOTAL	37.7%	17.5%	44.8%	
EXTREME DRY EVENT (1999-2003)				
TOTAL NITROGEN	159	537	826	1,522
% OF TOTAL	10.4%	35.3%	54.3%	
TOTAL PHOSPHORUS	683	313	660	1,656
% OF TOTAL	41.2%	18.9%	39.9%	

[1]Forest nonpoint source load = HSPF simulated loads from Forest North and Forest South land uses; average of 1990-2003 loads used for average scenario; 1993 loads used for wet event; average of 1999-2003 loads used for dry event
[2]Resort nonpoint source load = HSPF simulated loads from Resort land uses; average of 1990-2003 loads used for average scenario; 1993 loads used for wet event; average of 1999-2003 loads used for dry event
[3]External point source load = HSPF simulated loads from residential and high density urban land uses; average of 1990-2003 loads used for average scenario; 1993 loads used for wet event; average of 1999-2003 loads used for dry event
[4]Total measured load = sum of items 1-3

Table A-9. Total nutrient loads to Summit Creek, in lbs.

Parameter	Forest NPS Load[1]	Resort NPS Load[2]	External Point Source Load[3]	Total Measured Load[4]
1990-2003				
TOTAL NITROGEN	22	813	488	1,323
% OF TOTAL	1.7%	61.5%	36.9%	
TOTAL PHOSPHORUS	69	279	545	893
% OF TOTAL	7.7%	31.2%	61.0%	
EXTREME WET EVENT (1993)				
TOTAL NITROGEN	115	4,896	2,757	7,768
% OF TOTAL	1.5%	63.0%	35.5%	
TOTAL PHOSPHORUS	383	1,807	3,748	5,938
% OF TOTAL	6.4%	30.4%	63.1%	
EXTREME DRY EVENT (1999-2003)				
TOTAL NITROGEN	4	133	147	284
% OF TOTAL	1.4%	46.8%	51.8%	
TOTAL PHOSPHORUS	17	78	107	202
% OF TOTAL	8.4%	38.6%	53.0%	

[1]Forest nonpoint source load = HSPF simulated loads from Forest North and Forest South land uses; average of 1990-2003 loads used for average scenario; 1993 loads used for wet event; average of 1999-2003 loads used for dry event
[2]Resort nonpoint source load = HSPF simulated loads from Resort land uses; average of 1990-2003 loads used for average scenario; 1993 loads used for wet event; average of 1999-2003 loads used for dry event
[3]External point source load = HSPF simulated loads from residential and high density urban land uses; average of 1990-2003 loads used for average scenario; 1993 loads used for wet event; average of 1999-2003 loads used for dry event
[4]Total measured load = sum of items 1-3

The majority of loads for all three scenarios for both total phosphorus and total nitrogen for the Summit Creek subwatershed are from the resort and urban land uses. The forest land use contributes less than 2% of the total nitrogen loads and less than 10% of the total phosphorus loads.

Table A-10. Total nutrient loads to Grout Creek, in lbs.

Parameter	Forest NPS Load[1]	Resort NPS Load[2]	External Point Source Load[3]	Total Measured Load[4]
1990-2003				
TOTAL NITROGEN	1,251	0	309	1,560
% OF TOTAL	80.2%	0.0%	19.8%	
TOTAL PHOSPHORUS	4,747	0	252	4,999
% OF TOTAL	95.0%	0.0%	5.0%	
EXTREME WET EVENT (1993)				
TOTAL NITROGEN	7,553	0	1,881	9,434
% OF TOTAL	80.1%	0.0%	19.9%	
TOTAL PHOSPHORUS	31,869	0	1,616	33,485
% OF TOTAL	95.2%	0.0%	4.8%	
EXTREME DRY EVENT (1999-2003)				
TOTAL NITROGEN	235	0	75	310
% OF TOTAL	75.8%	0.0%	24.2%	
TOTAL PHOSPHORUS	1,170	0	62	1,232
% OF TOTAL	95.0%	0.0%	5.0%	

[1]Forest nonpoint source load = HSPF simulated loads from Forest North and Forest South land uses; average of 1990-2003 loads used for average scenario; 1993 loads used for wet event; average of 1999-2003 loads used for dry event
[2]Resort nonpoint source load = HSPF simulated loads from Resort land uses; average of 1990-2003 loads used for average scenario; 1993 loads used for wet event; average of 1999-2003 loads used for dry event
[3]External point source load = HSPF simulated loads from residential and high density urban land uses; average of 1990-2003 loads used for average scenario; 1993 loads used for wet event; average of 1999-2003 loads used for dry event
[4]Total measured load = sum of items 1-3

There are no loads from resort land uses in the Grout Creek subwatershed. Over 95% of the total phosphorus loads for all three hydrological conditions are from forest land use. Total nitrogen loads are from forest land use (80%) with the remainder from urban land use.